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Innovations

Bluetooth Origin/Destination Demand Validation Study Using Video

Background: Location-based technologies (LBT) such as Bluetooth (see Figure 1), cellular probes, toll tags and automatic license plate recognition (ALPR) had mostly been studied for their potential to collect average travel times for traveler information purposes. In contrast, this study looked at the feasibility of using LBT for deriving origin/destination (OD) demands and other more sophisticated transportation data. Traditionally, such sophisticated data were limited in accuracy and costly to produce using methods such as modeling, traveler surveys or activity-analysis. This study used a special event, a University of Missouri basketball game, to assess the potential of using LBT at larger events such as MU football or St. Louis Cardinals baseball. This feasibility study was unique in that it used a video validation approach that was able to provide a completely reliable groundtruth.

Results: One main question asked by this study was, "Could OD demands be collected directly from LBT instead of traditional methods?" The video validation data showed that OD trip rates could be measured directly as long as the sampling rate is high. But the Bluetooth sampling rate of 6% was too low to produce accurate OD percentages or OD trip rates. In contrast, the validation data produced very fine data, i.e. five-minute and hourly trip rates. Table 1 shows an example of the five-minute trip rates measured for the Stadium/I-70 and Stadium/Providence OD pair. Such data is useful for real-time applications but could easily be aggregated to produce daily trip rates suitable for longer-term planning purposes.

Start Time	OD Demand (trips/hour)
10:07:00	1368
10:16:00	1248
10:21:00	1032
10:26:00	864
10:47:00	1092

Another question that was explored was, "What are the potential uses ~~of~~ the data collected in the study?" In terms of traffic management and operations, the detailed OD data painted a clear picture of the traffic patterns before and after the event. Table 2 shows that trips were dominated by Stadium to US-63 (947 trips/hour) as compared to Providence to I-70 (224 trips/hour) for the outbound traffic. The trip rate was over four times higher on Stadium while the travel time was 45% less.

OD pair	Stadium Blvd. (Monk to 63)	Providence. (Stad. to I-70)
Time Period	~1:35 to 1:51 pm	~1:30 to 2:30 pm
Trip rate (trips/hour)	947	224
Average travel time	0:03:09	0:05:44

Another type of data that is useful for traffic management is travel time over time. Figure 2 shows an example of such data for the Monk to US-63 segment of Stadium. The knowledge of such temporal traffic patterns allows engineers to better optimize the signal timing for special events. It allows engineers to know when to change timing plans from a regular plan to priority plans that favor certain corridors. And it allows engineers to tweak the timing plans to suit the intensity of the corridor traffic nearing an event. More importantly, the knowledge of traffic patterns is critical during incidents where efficient diversion routes are needed to mitigate secondary traffic effects. Such travel time information can also help to better inform travelers.

In terms of transportation planning, the measured OD demands could be used as an input to planning models and/or to validate and calibrate such models. The validation and calibration can occur at both the trip distribution level and the path assignment level since path flows and path travel times can be measured directly. As shown in Table 2, trip rates were tracked directly throughout the special event.

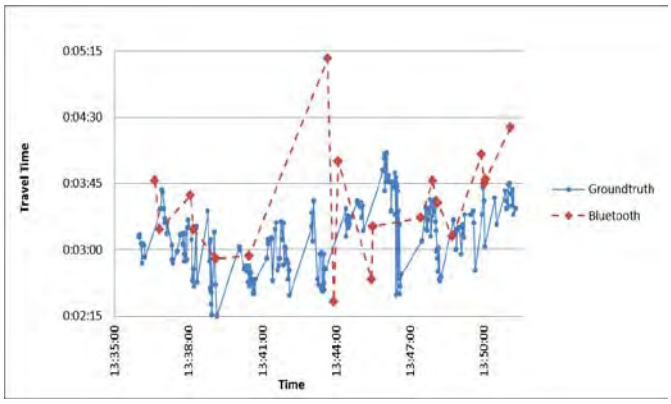

Figure 2 Westbound Stadium (Monk to US-63) travel times

By using LBT data, there is potential for better harmony between transportation planning and traffic operations. The traditional link between the two was tenuous because volumes used to calibrate planning models do not result in unique traffic patterns, i.e. vehicles that take completely different paths could have produced the same exact volume counts. By using LBT, the same data could be used in both planning and traffic management, resulting in greater consistency. This point was raised by a FHWA Columbia region traffic management report.

Additional Developments:

ALPR systems should be investigated in Missouri as demonstrated by the video validation data. MoDOT has already explored cellular probes in Kansas City, magnetic tracking on arterials in St. Louis and Bluetooth in Mid-Missouri. In contrast to high Bluetooth and magnetic costs, MoDOT could utilize its significant video infrastructure throughout the state in urban and rural areas, and both on freeways and arterials. The potential for utilizing such video systems for deriving more types of data is noteworthy for its cost-savings and flexibility. The validation data from this case study shows that such ALPR systems could potentially produce a wide range of useful data including travel times, travel time reliability and OD trip rates.